ARJUNA

JEE

LECTURE - 14

Mole Concept

Sarvesh sir

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Q. 1litre , 0.2M HNO_3 solution diluted to ~~99~~ 100 times of initial solution , find out the molarity of final solution

20sec

A 0.002M

B 0.02M

C 0.2 M

D 0.0002 M

(No. Mole of solute)$_{\text{before}}$ = (No. of mole of solute)$_{\text{After}}$

$0.2 \times 1 = M \times 100$

$M = \frac{0.2}{100} = 0.002$

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Normality

⇒ Reduction - oxidation chapter → Redox Reactⁿ. or Redox titration

" total No. of gram Equivalent of solute dissolved in 1 litre of solution "

$$\text{Normality (N)} = \frac{\text{No. of gram Equivalent of solute}}{\text{Volume of solution (Litre)}}$$

$$\text{No. of gram Equivalent} = \frac{\text{Wt. of solute}}{\text{Equivalent. wt}}$$

$$\text{Equivalent wt.} = \frac{\text{Molecular wt.}}{n\text{-factor}}$$

$$\text{No. of gram Equivalent of solute} = \frac{\text{wt. of solute}}{\text{Eq. wt}}$$

$$= \frac{\text{wt. of solute}}{\frac{\text{M. wt}}{n\text{-factor}}}$$

No. of gram Eq. of solute = mole of solute $\times$ n-factor

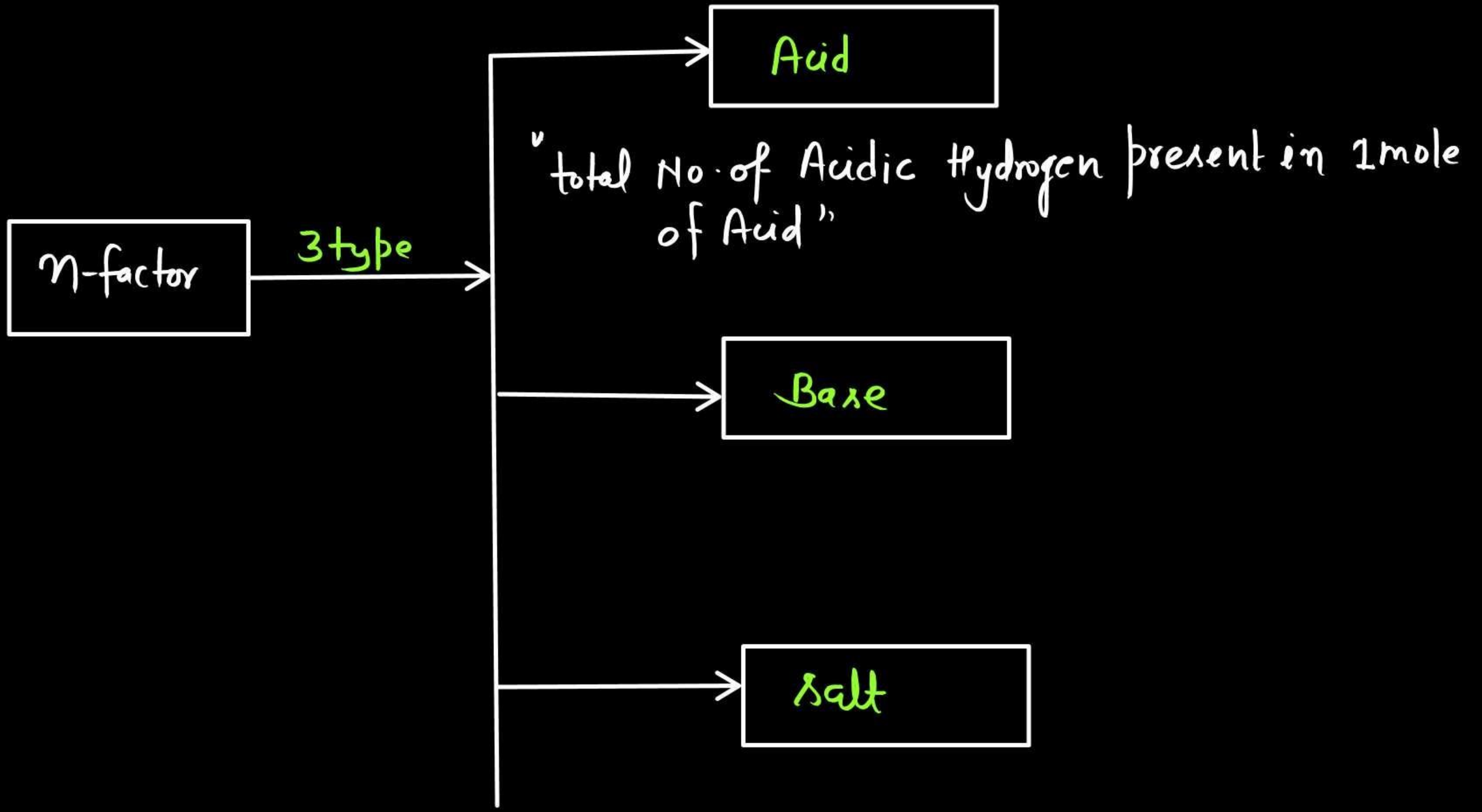
$$= \left(\frac{\text{wt. of solute}}{\text{M. wt}}\right) \times n\text{-factor}$$

$C_{SD} = 42$

① $N = \dfrac{\text{No. of gram Eq. of solute}}{\text{Vol. of sol}^{n}\text{ (litre)}}$

② No. of gram Equivalent $= \dfrac{\text{wt.}}{\text{Eq. wt}} = n\text{-factor} \times \text{No. of mole solute}$

③ Equivalent wt. $= \dfrac{\text{Molecular wt}}{n\text{-factor}}$


n-factor
3 type
Acid
"total No. of Acidic Hydrogen present in 1mole of Acid"
Base
Salt

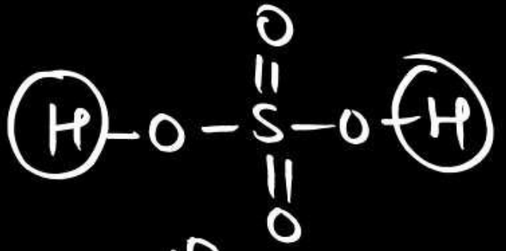
n-factor of Acid ⇒ total No. of mole of acidic Hydrogen present in 1 mole of acid

Condition →

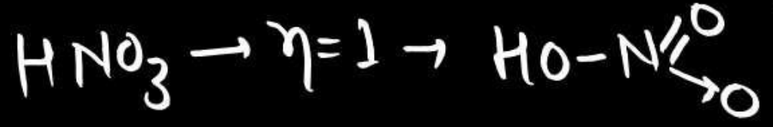
O — H
δ — H → Acidic Hydrogen
X — H

Ex → HCl → n = 1

H_2SO_4 → n = 2 ⇒



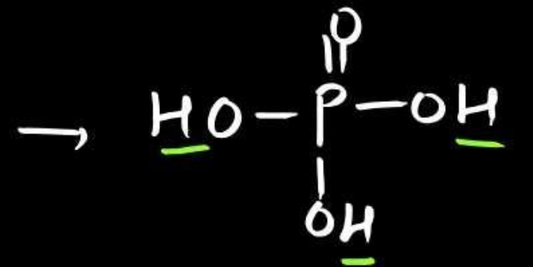
HNO_3 → n = 1 →

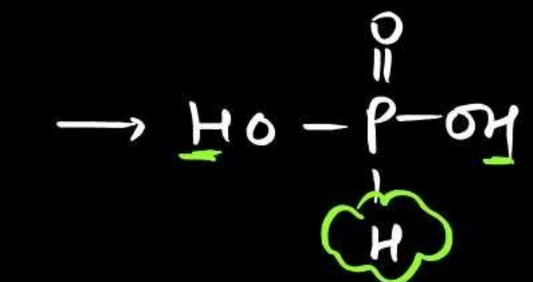


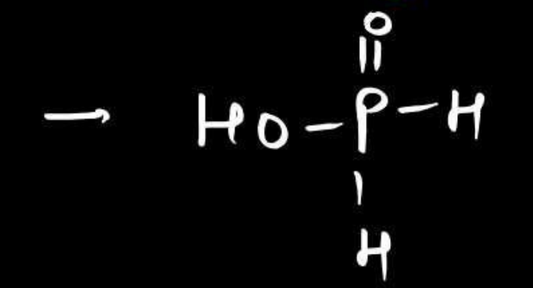
Eq. wt of HCl = $\frac{\text{M.wt}}{1}$

Eq. wt of H_2SO_4 = $\frac{\text{M.wt}}{2}$

Eq. wt of HNO_3 = $\frac{\text{M.wt}}{1}$

H_3PO_4 →  → $\eta = 3$

H_3PO_3 →  → $\eta = 2$

H_3PO_2 →  → $\eta = 1$

Q

98 gram H_3PO_4 dissolved in 2 litre water. Calculate Normality of H_3PO_4 sol^n.

Sol^n $N = \dfrac{\text{No. of gram Eq. of } H_3PO_4}{\text{Vol. of sol}^n}$

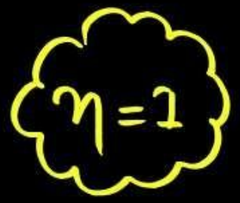
$= \dfrac{3}{2} = 1.5N$

E. wt of $H_3PO_4 = \dfrac{98}{3}$

No. of gram Eq. of $H_3PO_4 = \dfrac{98}{\frac{98}{3}} = 3$

Q $CH_3-\overset{\overset{O}{\|}}{C}-O-H$ → Acetic acid

Find out n-factor



(a) 1

(b) 2

(c) 3

(d) 4

n-factor of Base

total No. of mole of OH^- present in 1mole Base

$NaOH \rightarrow n = 1$

$Ba(OH)_2 \rightarrow n = 2$

$Al(OH)_3 \rightarrow n = 3$

Q Eq. wt of $Ca(OH)_2$ (M.wt = 74)

(a) $\frac{74}{1}$

(b) $\frac{74}{2}$

(c) $\frac{74}{3}$

(d) None of these

$$\text{Eq. wt} = \frac{\text{M. wt}}{\text{n-factor}}$$

$$= \frac{74}{2}$$

Q 4 gram NaOH dissolved in 1 litre sol^{n}.
Calculate normality of NaOH sol^{n}.

(a) 0·1 N
(b) 0·2 N
(c) 0·01 N
(d) None of these

$$N = \frac{\text{No. of gram Eq. of solute}}{\text{Vol. of sol}^{n}.}$$

$$= \frac{0.1}{1} = 0.1\,N$$

$$\text{No. of gram Eq. of solute} = n \times \text{mole} = 1 \times \frac{4}{40} = 0.1$$

$$= \frac{\text{wt}}{\text{Eq. wt}}$$

n-factor of salt = total No. of mole of +ve charge or -ve charge in 1 mole of salt

Ex → $NaCl \rightarrow Na^{+} + Cl^{-} \rightarrow n = 1$

$Na_2CO_3 \rightarrow 2Na^{+} + CO_3^{-2}$

↓

n-factor of $Na_2CO_3 = 2$

Ex → $Ca_3(PO_4)_2 \rightarrow n = 6$

$3Ca^{+2} + 2PO_4^{-3}$

Ex → $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

$n = 4SO_4^{-2} = (8)$

$= 2K^{+} + 2Al^{+3}$

$= 2 + 6 = (8)$

Ex → Eq.wt of Na_3PO_4

(a) $\frac{M.wt}{1}$

(b) $\frac{M.wt}{2}$

(c) $\frac{M.wt}{3}$

(d) $\frac{M.wt}{4}$

$Eq.wt = \frac{M.wt}{n\text{-factor}}$

$= \frac{M.wt}{3}$

$Na_3PO_4 \rightarrow 3Na^{+} + PO_4^{-3}$

Relation between Normality and Molarity

Normality = n-factor × Molarity

Q. 10.6 gram Na_2CO_3 dissolved in 200 ml solution

Calcula Normality of solution.

Sol ⇒ (M-1) $M = \frac{10.6/106}{200 \times 10^{-3}} = \frac{0.1 \times 1000}{200} = 0.5M$

$N = n \times M = 2 \times 0.5 = 1.0N$

(M-2) $N = \frac{\text{gram Eq. of } Na_2CO_3}{\text{Vol. of sol}^n} = \frac{0.2}{200 \times 10^{-3}} = 1N$

gram Eq. of $Na_2CO_3 = \frac{10.6}{\text{Eq. wt}} = \frac{10.6}{\frac{106}{2}} = 0.2$

$\text{Eq. wt} = \frac{\text{M. wt}}{n} = \frac{106}{2}$

Stoichiometric calculation

→ Calculation of amount of Reactant or product in a chemical rxn

$C_{SD}=42$

① Reaction Ko balance karo

② given information Ko mole me Convert Karo

③ $n_1A + n_2B \longrightarrow n_3AB$ (Balance Rxn)

$$\frac{(\text{mole})_A}{n_1} = \frac{(\text{mole})_B}{n_2} = \frac{\text{mole of AB}}{n_3}$$

Jo diya jaye aur jo Question me puchha jaye, Uske mole Ka ratio barabar Kr do.

CEO.

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Stoichiometry

Definition: Stoichiometry pronounced ("stoy – key – om – e – tree") is the calculations of the quantities of reactants and products involved in a chemical reaction, following methods can be used for solving problems:

Rule

(a) **Mole Method** (Balancing is required)

(b) All reactant and product convert in to **mole form**

2 mol of H_2S react SO_2 gas at high temperature and ~~sulphur~~ pressure. What amount of sulphur form after complete the reaction: (At. Weight S = 32, H = 1 , O = 16)

$$SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$$

$w = ?$

(a) 118 g
(b) 84.3 g
(c) 11 g
(d) 96 g

$$\frac{(\text{mole})_{H_2S}}{2} = \frac{(\text{mole})_S}{3}$$

$$\frac{2}{2} = \frac{(\text{mole})_S}{3}$$

mole of S = 3 mole

wt. of S = 3 × 32 = 96 gram

Q What amount of nitrogen gas required to react with 32 gram oxygen gas.

$$N_2 + O_2 \longrightarrow NO_2$$

(a) 14 gram

(b) 28 gram

(c) 7 gram

(d) None of these

Sol^n $N_2 + 2O_2 \longrightarrow 2NO_2$

$\frac{32}{32} = 1 \text{ mole } O_2$

$$\frac{(\text{mole})_{N_2}}{1} = \frac{(\text{mole})_{O_2}}{2}$$

Mole of $N_2 = \left(\frac{2}{2}\right) \times 1 = 1 \text{ mole}$

Amount of $N_2 = 1 \times 28 = 28 \text{ gram}$

Q. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene?

Home work

A 2.8 kg

B 6.4 kg

C 9.6 kg

D 96 kg

$$C_2H_4 + O_2 \longrightarrow CO_2 + H_2O$$

Q. Assuming fully decomposed, the volume of CO_2 released at STP on heating 9.85 g of $BaCO_3$ (at mass of Ba = 137) will be

(A) 1.12 L

(B) 0.84 L

(C) 2.24 L

(D) 4.96 L

Ba = 137
C = 12
3×O = 48
→ 197

Vol. of gas at S.T.P = mole × 22.4 L

Sol^{n} → $BaCO_3 \xrightarrow{\Delta} BaO + CO_2$

9.85 gram

$\frac{9.85}{197}$ mole

$\frac{(\text{mole})_{BaCO_3}}{1} = \frac{(\text{mole})_{CO_2}}{1}$

mole of $CO_2 = \frac{9.85}{197}$ mole

Vol. of CO_2 at S.T.P = $\frac{9.85}{197} \times 22.4\,L = 1.12\,L$

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Q. For the following reaction, the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is $2C_{57}H_{110}O_6(s) + 163O_2(g) \rightarrow 114CO_2(g) + 110\ H_2O(l)$

(Jee-Main 2019)

$\frac{445\ gram}{890} = \frac{1}{2}$ mole

A 490 g

B 495 g

C 445 g

D 890 g

$57 \times 12 = 684$

$1 \times 110 = 110$

$6 \times 16 = 96$

890

$\frac{(Mole)_{C_{57}H_{110}O_6}}{2} = \frac{(Mole)_{H_2O}}{\frac{110}{55}}$

Mole of $H_2O = 55 \times \frac{1}{2}$ mole

Mass of $H_2O = 55 \times \frac{1}{2} \times 18^{9} = 495\ gram$

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Q. 1 g of carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is

(Jee-Main 2017)

0.01186 mole

A	1186	B	84.3
C	118.6	D	11.86

$$M_2CO_3 + 2HCl \longrightarrow 2MCl + CO_2 + H_2O$$

$\left(\frac{1}{m.wt}\right)$ mole — 0.1186 mole

$$\frac{\left(\frac{1}{m.wt}\right)}{1} = \frac{0.01186}{1}, \quad m.wt = \frac{1}{0.01186} = \underline{84.3}$$

Q. A metal oxide has the formula Z_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of the metal oxide requires 6 mg of hydrogen for complete reduction. They atomic weight of the metal is

A 27.9

B 159.6

C 79.8

D 55.8

$$Z_2O_3 + 3H_2 \longrightarrow 2Z + 3H_2O$$

(? above Z)

0.1596 gram $\quad 6\times10^{-3}$ gram

$\frac{0.1596}{(2A+48)}$ mole $\quad \frac{6\times10^{-3}}{2}$ mole $= 3\times10^{-3}$ mole

$$\frac{\left(\frac{0.1596}{2A+48}\right)}{1} = \frac{3\times10^{-3}}{3}$$

$$\frac{0.1596}{10^{-3}} = 2A+48$$

$$159.6 = 2A+48$$

$$2A = 111.6$$

$$A = 55.8$$

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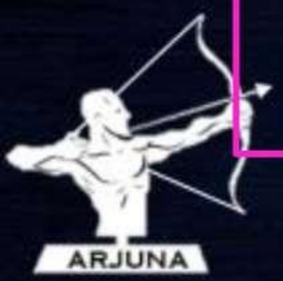
Case-02 , percentage purity of sample (reactant)

$C_{SD}=43$ Calculate mass of pure substance by given information

① (jiski % purity puchhi jaye usi ka mass nikal dena

$$\%\ \text{purity} = \frac{\text{mass of substance}}{\text{mass of sample of substance}} \times 100$$

② $\text{mass of pure substance} = \frac{\text{mass of sample} \times \%\ \text{purity of substance}}{100}$



Q. 15 gram $CaCO_3$ sample heated at high temperature and form 5.6 gram of CaO and CO_2 gas

$$CaCO_3 \longrightarrow \underset{5.6\,g}{CaO} + CO_2$$

Calculate percentage purity of sample.

(a) 75%

(b) 60%

(c) 66.67%

(d) 33.34%

$$\frac{5.6}{56} = 0.1 \text{ mole CaO}$$

$$\frac{(\text{mole})_{CaCO_3}}{1} = \frac{(\text{mole})_{CaO}}{1}$$

Mole of $CaCO_3$ = 0.1 mole

Mass of $CaCO_3$ = 0.1 × 100 = 10 gram

$$\% \text{ purity} = \frac{\text{Mass of } CaCO_3}{\text{mass of sample}} \times 100$$

$$= \frac{10^{2}}{15} \times 100$$

$$= \frac{200}{3} = 66.67\%$$

Q. Percentage purity of $CaCO_3$ is 66.67% in 15 gram of $CaCO_3$ sample

$$CaCO_3 \longrightarrow CaO + CO_2$$

Calculate amount of CaO form

(a) 5.6 gram
(b) 10 gram
(c) 7.5 gram
(d) None of these

pure mass of $CaCO_3 = \frac{15 \times 66.67}{100}$

$= 10$ gram

$CaCO_3 \longrightarrow CaO + CO_2$

10 gram

$\frac{10}{100}$ mole

$= 0.1$ mole

$\frac{0.1}{1} = \frac{(\text{mole})_{CaO}}{1}$

Mole of CaO = 0.1 mole

Mass of CaO = 0.1 × 56

= 5.6 gram

Q. 20.0 g of a magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.0 g magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample? (Atomic weight of Mg = 24)

A 75

B 96

C 60

D 84

$MgCO_3 \longrightarrow MgO + CO_2$

8 gram

$\frac{8}{40} = \frac{1}{5}$ mole

$\frac{(mole)_{MgCO_3}}{1} = \frac{(mole)_{MgO}}{1}$

mole of $MgCO_3 = \frac{1}{5}$ mole

Mass of $MgCO_3 = \frac{1}{5} \times 84$ gram

% purity of $MgCO_3 = \frac{(W)_{MgCO_3}}{\text{Sample}} \times 100$

$= \frac{84/5}{20} \times 100$

$= \frac{84 \times 100}{20 \times 5}$

$= 84\%$

Case-04 , successive reaction

$C_{SD} = 44$ $\left(\frac{\text{Mole}}{\text{Coeff.}}\right)$ Ratio wala Concept 1 se jada bar lagana hota.

- $A \rightarrow 2B \rightarrow \left(\frac{\text{mole}}{1}\right)_A = \left(\frac{\text{mole}}{2}\right)_B$

$3B \rightarrow 4C$ $\hookrightarrow \left(\frac{\text{mole}}{3}\right)_B = \left(\frac{\text{mole}}{4}\right)_C$

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Q $2A + B \longrightarrow A_2B$

$A_2B + C_2 \longrightarrow 2AC + B$

0.5 mole of A react with B and form A_2B, A_2B further react with C_2, what mole of AC form.

(a) $\frac{0.5}{2}$ mole (B) 1 mole

(b) 0.5 mole (d) 1.5 mole

Sol^n $\frac{(\text{mole})_A}{2} = \frac{(\text{mole})_{A_2B}}{1}$

mole of $A_2B = \frac{1}{2} \times 0.5 = \frac{0.5}{2}$ mole

$\frac{(\text{mole})_{A_2B}}{1} = \frac{(\text{mole})_{AC}}{2}$

$\frac{\frac{0.5}{2}}{1} = \frac{(\text{mole})_{AC}}{2}$

$(\text{mole})_{AC} = \frac{0.5}{2} \times 2 = 0.5$ mole

Q $2S + 3O_2 \longrightarrow 2SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

How many amount of H_2SO_4 form, when 1mole Sulphur react with Oxygen (O_2).

(a) 98 gram (b) 49 gram

(c) 100 gram (d) 196 gram

Sol^{n} $\frac{(mole)_S}{2} = \frac{(mole)_{SO_3}}{2}$

$(mole)_{SO_3} = 1mole$

$\frac{(mole)_{SO_3}}{1} = \frac{(mole)_{H_2SO_4}}{1}$

mole of $H_2SO_4 = 1mole$

mass of $H_2SO_4 = 1 \times 98 = 98$ gram

Case-03 , percentage yields of reaction

→ efficiency of Reaction

→ Kitne % Reaction ho rahi hai

or

→ Kitne % Reaction hue hai

CSD=45 → Jis product ki value Question me di jaye, usi product ki Value ko nikal dena.

$$\%\ \text{yields or Rxn yields \%} = \frac{\text{Experimental value}}{\text{theoretical value}} \times 100$$

Exp. value ⇒ alway given in Question (product ki)

theoretical value = Calculated by students.

Q 2 mole Calcium Carbonate heated at high temperature and form 1.2 mole of CaO as a product.

$$CaCO_3 \longrightarrow CaO + CO_2$$

Calculate percentage of reaction yields

(a) 60%.

(b) 50%.

(c) 80%.

(d) 30%.

$$\frac{(\text{mole})_{CaCO_3}}{1} = \frac{(\text{mole})_{CaO}}{1}$$

mole CaO = 2 mole

$$\% \text{ yields} = \frac{1.2}{2} \times 100$$

$$= \frac{120}{2} = 60\%$$

Q $N_2 + 2O_2 \longrightarrow 2NO_2$

14 gram N_2 react with oxygen (O_2), and form 23 gram of NO_2

Calculate % yields of Reaction.

(a) 60%.

(b) 40%.

(c) 50%.

(d) 70%.

$\frac{14}{28} = \frac{1}{2}$ mole N_2

$\frac{(\text{mole})_{N_2}}{1} = \frac{(\text{mole})_{NO_2}}{2}$

$\frac{1}{2} \times 2 =$ mole of NO_2

mole of $NO_2 = 1$ mole, Mass of $NO_2 = 1 \times 46 = 46$ gram

% yields $= \frac{23}{46} \times 100 = 50\%$

Home work

DPP 10

Thank - You